



A revision of *Microbothriorhynchus* Yamaguti, 1952 (Cestoda: Trypanorhyncha), with the redescription of *M. coelorhynchi* Yamaguti, 1952 and the description of *M. reimeri* n. sp.

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Abstract

The genus *Microbothriorhynchus* Yamaguti, 1952 is revised. Plerocerci of *M. coelorhynchi* Yamaguti, 1952 from the body-cavity of *Brotula barbata* (Bloch & Schneider) off the Angolan coast are re-described, and *M. reimeri* n. sp. from the body-cavity of *Helicolenus maculatus* (Cuvier) and *Caelorinchus parallelus* (Günther) from coastal waters off Mozambique is added to the genus. Both species are characterised in having an elongated, slightly craspedote scolex with small, collar-like bothridia, an elongate pars vaginalis and very long bulbs. The tentacular armature is heteroacanthous atypica, with eight principal hooks and intercalary hooks merging with a band of spiniform hooks on the external tentacle surface. The adult is unknown. *Microbothriorhynchus* is allocated to the Lacistorhynchidae Guiart, 1927, in having a blastocyst, two bothridia and a heteroacanthous atypica armature. *Dasyrhynchus* Pintner, 1928 and *Pseudogrillotia* Dollfus, 1969 are considered the most closely related genera, sharing characters such as the craspedote scolex, similar scolex proportions and hook patterns. *Microbothriorhynchus* appears to link the heteroacanthous atypica genera *Grillotia* Guiart, 1927 and *Pseudogrillotia* with the poecilacanthous genus *Dasyrhynchus*.

Introduction

Yamaguti (1952) described *Microbothriorhynchus coelorhynchi*, from the body-cavity of *Caelorinchus* sp., as a new species and genus, which he could not assign to any known trypanorhynch family. The specimens, obtained from Maisaka, Sizuoka Prefecture, Japan, were well illustrated, sharing several characters, such as scolex proportions, elongate bulbs and a slightly craspedote scolex, with the Dasyrhynchidae Dollfus, 1935. However, the armature was heteroacanthous atypica, thus placing the species within the 'Hétéracanthes' and not the 'Pécilacanthes' of Dollfus (1942), and making assignment of the species to any of Dollfus' trypanorhynch families difficult.

Yamaguti (1959) considered *Microbothriorhynchus* as a genus *incertae sedis*. Wardle et al. (1974) did not include Yamaguti's (1952) contribution to

trypanorhynch taxonomy. Both Schmidt (1986) and Campbell & Beveridge (1994) also listed *Microbothriorhynchus* as a genus *incertae sedis*, the latter authors because the type is lost – it cannot be found in the Meguro Parasitological Museum. Also, Palm (1995, 1997), using only genera accepted by Campbell & Beveridge (1994), did not include the species within his alternative trypanorhynch classification.

The present study redescribes *Microbothriorhynchus coelorhynchi* obtained from southeast Atlantic waters and adds a further species to the genus. The latter specimens were previously identified by Reimer (1984) as *Pseudogrillotia* sp. from the deep-sea macrourid *Caelorinchus parallelus* (Günther) from Mozambique. The diagnosis of *Microbothriorhynchus* Yamaguti, 1952 is amended below and the genus is considered valid. Evidence for a phylogenetic relationship with other trypanorhynch genera is presented and its im-

plication for recent trypanorhynch classifications is discussed.

Materials and methods

Specimens of *Microbothriorhynchus coelorhynchi* were obtained from the collection of A. Kovaleva, AtlantNIRO, Kaliningrad, Russia. The plerocercoids were collected from a 50 cm female *Brotula barbata* (Bloch & Schneider) from off the Angolan coast in the south-east Atlantic. Plerocercoids of a new *Microbothriorhynchus* species were obtained from the collection of L.W. Reimer. The material was collected between 17°31' and 26°30'S in coastal waters off Mozambique between January and February, 1982 (see Reimer, 1984). All specimens were measured, drawn and then re-mounted in Canada balsam.

For species descriptions, the following abbreviations are used for the different body parts of the trypanorhynchs: *pars bothridialis* (pbo), *pars vaginalis* (pv), *pars bulbosa* (pb), *pars postbulbosa* (ppb), *appendix* (app), *velum* (vel) and scolex proportions (SP) [pbo: pv: pb]. Drawings were made with the aid of a drawing tube attached to an Olympus Dialux 22 microscope. Scolex measurements of the type-material and hook measurements of 10 hooks each were made with an ocular micrometer, and are given in micrometres unless otherwise indicated. The orientation of tentacle surfaces and the classification follows that of Dollfus (1942) and Palm (1995, 1997), respectively.

Family Lacistorhynchidae Guiart, 1927

Microbothriorhynchus coelorhynchi Yamaguti, 1952

Material studied: Neotype and voucher from the body-cavity of *Brotula barbata* (Bloch & Schneider), 04.xii.1976, from coastal waters off Angola, south-east Atlantic.

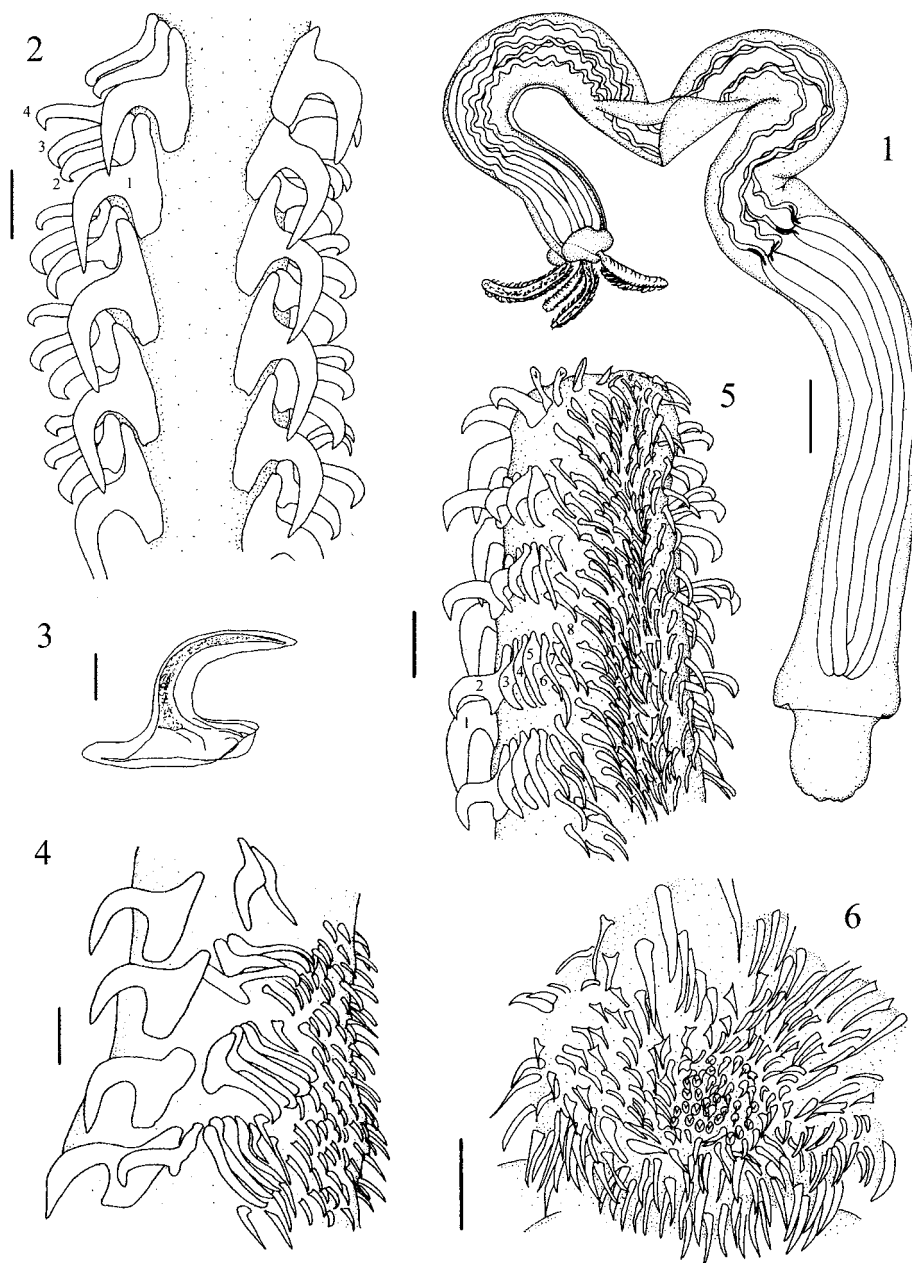
Description (Figures 1-6)

(Based on 2 specimens). With characters of *Microbothriorhynchus* Yamaguti, 1952. Scolex elongate and slender, 24.30, 22.42 mm long, 915-1,080, 898-1,197 wide at pv, widening posteriorly to 1,581, 1,563 at pb and 2,112, 2,079 at ppb, slightly craspedote (Figure 1), with distinct scolex tegument; 2 short, 'collar-like'

bothridia with posterior notch and free margins; bothridial pits absent; pbo 565, 565 long and 1,048, 1,031 wide; pv long and slender, 13.77, 13.69 mm; pb 8.52, 8.48 mm long; ppb 400, 400 long; vel 150, 150 long; app 1, 613 × 1, 364, 1, 613 × 1, 364, with posterior end covered with hair-like microtriches. SP 1: 24: 15. Tentacle sheaths straight in anterior pv and sinuous to coiled in remainder; bulbs 7,880-8,520, 8,180-8,481 long, 230-300, 230-280 wide; length to width ratio 26.3-37.0:1, 29.2-36.9:1; prebulbar organ absent; bulbs end anterior to *pars proliferans* of scolex; origin of retractor muscle at anterior end of bulbs. Fully everted tentacles 2,155-2,255, 1,896-1,937 long; basal swelling absent; diameter at base 120-133, 59-93, at mid-region 146-166, 165-179, at distal extremity 100-110, 119-132.

Armature heteroacanthous atypica (Figures 2-6); hollow hooks, arranged in half spiral rows of 8 principal hooks, diminishing in size along row; 3 rows of 1-2 spiniform intercalary hooks present between each principal row. Hooks of intercalary rows merge with band of hooks on external tentacle surface. Hooks 1 (1') large (Figures 2-3), rose-thorn shaped, 153-178 long, with elongate base 110-132, with distinct space between hooks 1 and 1' (Figure 2); hooks 2 (2') rose-thorn shaped, elongate, 102-119 long, with shorter base 65-73; hooks 3 (3') falcate, long and slender, 95-100 long, with short base 50-56; hooks 4 (4')-5 (5') falcate, slender, with recurved tip, decreasing in size; hooks 4 (4') 88-95 long, with base 40-45; hooks 5 (5') 81-88 long, with base 35-40; hooks 6 (6')-8 (8') spiniform 60-76 long, with base 17-24 (Figure 4). Intercalary hooks L = 43-56, B = 8-14 (Figures 4-5), aligned with hooks of band on external surface (Figures 4-5). Band of hooks consisting of c. 8-10 files of hooks, 45-55 long, base triangular 12-15, with smallest hooks in mid-line of external surface, 34-38 long, base 7-10. Hook shape elongate spiniform, with c. 6 rows of hooks between each principal row. Characteristic basal armature (Figure 6) of spiniform hooks of different size in ascending rows. Internal surface of smaller rose-thorn shaped hooks, 51-68 long, base 42-48, followed by smaller triangular shaped hooks; on external surface, slender spiniform and uncinatate hooks present; small trapezoidal area of prominent uncinatate hooks in array of approximately 7 × 7 hooks present (Figure 6).

Adult unknown.



Figures 1-6. *Microbothriorhynchus coelorhynchi* Yamaguti, 1952 from *Brotula barbata*. 1. Scolex. 2. Internal tentacle surface, metabasal. 3. Hook 1 on internal tentacle surface, metabasal. 4. Bothridial tentacle surface, metabasal. 5. External tentacle surface, metabasal. 6. External tentacle surface, basal. Scale-bars: 1, 1.5 mm; 3, 25 μ m; 2, 4-5, 60 μ m; 6, 35 μ m.

Remarks

Yamaguti (1952) characterised *Microbothriorhynchus coelorhynchi* obtained from blastocysts from *Caelorinchus* sp. off Maisaka, Sizuoka Prefecture, Japan, by having a very long scolex (19-22 mm) with two small collar-like bothridia and a long, slender pv (10-12 mm)

and pb (8.5-10 mm). Stout hooks, 165 long with a 120 long base (hooks 1 (1')), are arranged on the internal tentacle surface, with a wide space between them. Numerous slender spiniform hooks on the external surface and comb-like groups of five hooks, strongly curved near their tip, occur along the proboscis sides. The material described above corresponds in having a

similar scolex size (19-22 vs 22-24 mm in the present study), form (cf. figure 87 of Yamaguti, 1952, and Figure 1) and a similar tentacular armature (cf. figures 88-89 of Yamaguti, 1952, and Figures 2-5). The scolex proportions and hooks sizes also lie within the same range. Thus, the above material from *Brotula barbata* from the south-east Atlantic is identified as *Microbothriorhynchus coelorhynchi* Yamaguti, 1952.

Campbell & Beveridge (1994) published a key for the identification of trypanorhynch cestodes based on an examination of all available type-species of recognised genera and as many representative congeners as possible. For *Microbothriorhynchus coelorhynchi*, the type-material is no longer available, and cannot be located in the Meguro Parasitological Museum. As the material above is conspecific with the material described by Yamaguti (1952), one of the present specimens is considered to represent the neotype of *Microbothriorhynchus coelorhynchi*, the type-species of *Microbothriorhynchus* Yamaguti, 1952. *Brotula barbata* is a new host and the type-host for *M. coelorhynchi* (International Code of Zoological Nomenclature (ICZN 2000, Article 75), and its locality represents a new type-locality (ICZN 2000, Article 76.3). The distribution of the species extends from the west Pacific to the south-east Atlantic, and deep-water fish appear to be the preferred host.

Taxonomic summary

Type-host: *Brotula barbata* (Bloch & Schneider), Ophidiidae.

Other host: *Caelorinchus* sp., Macrouridae

Site: Body-cavity, inside a blastocyst.

Type-locality: Off the coast of Angola, 17°01'1"S, 11°24'4"E, South East Atlantic.

Type-material: Neotype and voucher from the body-cavity of *Brotula barbata* from the coastal waters of Angola, 04.xii.1976, are in The Natural History Museum, London, BMNH reg. nos 2001.12.3.1 and 2001.12.3.2, respectively.

Microbothriorhynchus reimeri n. sp.

Syn. *Pseudogrillotia* sp. of Reimer (1984)

Material studied: Holotype and paratype from the body-cavity of *Helicolenus dactylopterus* (Delaroché), L.W. Reimer leg., 11.ii.1982, from coastal waters off Mozambique, south-west Indian Ocean, depth 470 m.

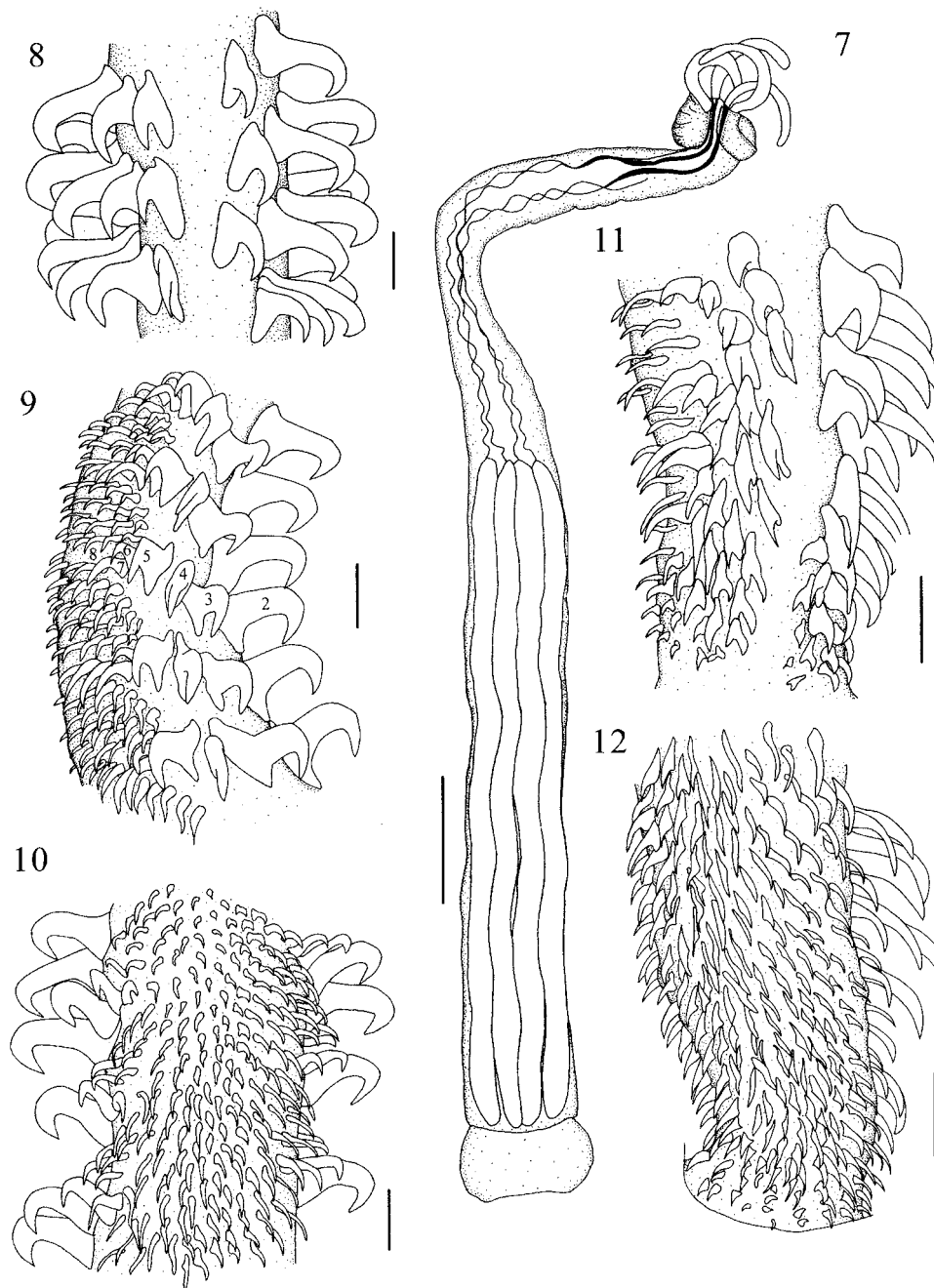
Other material: Plerocercoid from *Caelorinchus parallelus* (Günther), L.W. Reimer leg., 31.i.1982, from

coastal waters off Mozambique, south west Indian Ocean, depth 680 m.

Description (Figures 7-12)

(Based on 2 specimens). With characters of *Microbothriorhynchus* Yamaguti, 1952. Elongate blastocysts, 10-12 × 4-6 mm; scolex elongate, slender (Figure 7), 16.96, 17.78 mm long by 782-998, 549-1,114 wide at pv, widening posteriorly to 1,330-1,497, 1,396-1,430 at pb, slightly craspedote, with distinct scolex tegument; 2 short, 'collar-like' bothridia with posterior notch and free margins; bothridial pits absent, pbo 582, 832 long and 1,314, 1,197 wide; pv long and slender, 8.02, 7.72 mm; pb 7.78, 9.18 mm long; vel 23, 20 long; app 1, 164 × 1613, 881 × 1, 837, with posterior end covered with hair-like microtriches. SP 1:13.8:13.4, 1:9.3:11.0. Tentacle sheaths straight in anterior pars vaginalis and sinuous to coiled in remainder; bulbs 7.68-7.78, 9.14-9.18 mm long, 259-312, 285-331 wide; width/length ratio 24.6-30.0:1, 27.6-32.0:1; prebulbar organ absent; bulbs extend into *pars proliferans* of scolex; origin of retractor muscle at anterior end of bulbs. Tentacles not fully everted, 2,505-2,755, 1,912-2,162 long including invaginated part (Figure 7); basal swelling absent; diameter at base 185-219, 120-145, at mid-region 185-212, 152-172.

Armature heteroacanthous atypica (Figures 8-12); hollow hooks arranged in half spiral rows of 8 principal hooks, diminishing in size along row (Figures 8-10); 4 rows of intercalary hooks present between each principal row (Figure 9). Number of principal hooks per row, number of intercalary rows and shape of hooks same along tentacle. Hooks of intercalary and principal rows (from hook 6 (6')) merge with band of hooks on external tentacle surface (Figure 10). Hooks number 3-4 per intercalary row, L = 47-59 and B = 6.8-10.2 (Figures 9-10). Hooks 1 (1') large, rose-thorn shaped (Figure 8), 106-120 long, with elongate base 93-106; 2 (2') rose-thorn shaped, 106-120 long, base shorter 86-93; 3 (3') falcate, long and slender, 98-119 long, short base 59-79; hooks 4 (4') and 5 (5') falcate, long, slender, with re-curved tip, decreasing in size; 4 (4') 93-106 long, base 66-79; hooks 5 (5') 86-99 long, base 59-63. Hooks 6 (6') to 8 (8') spiniform, 53-73 long, short base 13-23 (Figures 9-10), of similar shape to hooks of band on external surface. Band of hooks consisting of c. 6-8 files of hooks (Figure 10), 40-46 long, base 6.5-8.5. Hook shape appears elongate, spiniform; hooks in mid-line of band slightly shorter with enlarged base



Figures 7-12. *Microbothriorhynchus reimeri* n. sp. from *Helicolenus maculatus*. 7. Scolex. 8. Internal tentacle surface, metabasal. 9. Bothridial tentacle surface, metabasal. 10. External tentacle surface, metabasal. 11. Internal tentacle surface, basal. 12. External tentacle surface, basal. Scale-bars: 7, 1.5; 8-12, 60 μ m.

(L = 29-31, B = 11.3-15.0). No distinct basal armature present (Figures 11-12); hook shapes in basal part only slightly differ from those in metabasal armature. On internal surface, tightly spaced smaller rose-thorn shaped hooks with shortened blade (Figure 11), triangular hooks, resembling sharks-teeth, with elongated base, appear on external surface (Figure 12). Hook form changes gradually towards metabasal armature.

Adult unknown.

Taxonomic summary

Type-host: *Helicolenus dactylopterus* (Delaroche), Scorpaenidae.

Other host: *Caelorinchus parallelus* (Günther), Macrouridae.

Site: Blastocysts in the body-cavity.

Type-locality: Coastal waters off Mozambique, 25°39'S, 33°28'E, south-west Indian Ocean, depth 470 m.

Type-material: Holotype and paratype from *H. maculatus* (length 32.5 cm) from the coastal waters off Mozambique, 11.ii.1982, collected by L.W. Reimer, in The Natural History Museum, London, reg. nos BM(NH) 2001.12.3.3 (holotype), 2001.12.3.4 (paratype). Specimen from *Caelorinchus parallelus* in the author's collection.

Etymology: The new species was named for the collector, L.W. Reimer, of Minden, Germany.

Remarks

Due to their elongate scolex, two collar-like, posteriorly notched bothridia, very long bulbs and a heteroacanthous atypica armature, the specimens described above are assigned to *Microbothriorhynchus Yamaguti*, 1952. However, they are not conspecific with *M. coelorhynchi*. The scolex is smaller (16.96-17.78 vs 22.42-24.30 mm), the scolex proportions (SP) are different (1:9.3-13.8:11.0-13.4 vs 1:24:15) and the tentacular armature differs distinctly in having differently shaped principal hooks [hooks 1-3 (1'-3') of similar length vs hook 1 (1') enlarged in comparison to hooks 2-3 (2'-3')] and no characteristic basal armature. Thus, the specimens described above represent a new species, which is named *M. reimeri* n. sp.

M. coelorhynchi has eight principal hooks and three rows of intercalary hooks merging with the spiniform hooks on the external tentacle surface. In *M. reimeri*, eight principal hooks are clearly distinguishable, but the number of intercalary rows is four. A similar hook pattern with the principal and inter-

calary hooks merging with the external hooks has been described for several other trypanorhynch genera, such as *Grillotia* Guiart, 1927, *Pseudogrillotia* Dollfus, 1969 and *Dasyrhynchus* Pintner, 1928 (see Sakanari, 1989; Beveridge & Campbell, 1993; Campbell & Beveridge, 1993).

Reimer (1984) reported the presence of *Pseudogrillotia* sp. in *Caelorinchus parallelus* from the Mozambique coast, which is herewith re-identified as *Microbothriorhynchus reimeri* n. sp.

***Microbothriorhynchus Yamaguti*, 1952 amended**

Diagnosis. Scolex craspedote, very long and slender, with 2 short, collar-like, posteriorly notched bothridia; pars vaginalis and pars bulbosa very long, followed by short appendix. Tentacles elongate, massive; basal swelling absent; retractor muscle originates at anterior end of bulbs. Metabasal tentacular armature heteroacanthous atypica; hooks on internal surface large, rose-thorn-shaped, becoming slender with recurved tip along bothridial/antibothridial surfaces and spiniform on external surface. Basal hooks heteromorphous; characteristic basal armature present or absent. Hooks hollow. Strobila unknown. Type-species: *M. coelorhynchi* Yamaguti, 1952.

Discussion

Microbothriorhynchus is a valid trypanorhynch genus, currently containing two species. Both can be easily distinguished from other trypanorhynchs in having a short pbo, long pv and very long bulbs, in combination with a heteroacanthous atypica armature. They are most similar to species of *Dasyrhynchus* Pintner, 1928, which have similar scolex proportions and a hook pattern with a similar large number of principal hooks and intercalary rows (Beveridge & Campbell, 1993). However, these species differ in having a chainette on the external tentacle surface. In *Dasyrhynchus talismani* Dollfus, 1935, the chainette is restricted to the basal part of the armature, while the metabasal armature is heteroacanthous atypica (Dollfus, 1942). In *Dasyrhynchus magnus* (Bilqees & Khurshid, 1985), hooks 1 (1') are similarly divergent along the internal surface of the tentacle; this is also the case in *M. coelorhynchi*. In other heteroacanthous or poeciloacanthous trypanorhynchs, these hooks are more convergent, thus a larger space free of hooks between the bothridial and antibothridial tentacle surfaces is missing.

Other similarities exist with *Pseudogrillotia* Dollfus, 1969, which includes species with a long and slender craspedote scolex and a heteroacanthous atypica armature with up to 10 principal hooks as well as several intercalary hooks, merging with a band of small and spiniform ones on the external tentacle surface (Dollfus, 1969; Campbell & Beveridge, 1993). However, the bulbs are much shorter than the pars vaginalis (see diagnosis of Campbell & Beveridge, 1994). The bulbs can be long in *Grillotia* Guiart, 1927; however, the scolex is acraspedote and in most species the principal hooks are less numerous (Sakanari, 1989). The most obvious difference between these two genera and *Microbothriorhynchus* are the very long bulbs in the latter and the form of the hooks on the external tentacle surface, which are often minute and uncinata in *Grillotia* and *Pseudogrillotia* but more elongate and spiniform in *Microbothriorhynchus*. A similar hook form on the external tentacle surface has been described in the metabasal and apical armature of *Dasyrhynchus talismani* Dollfus, 1935 and *D. pillersi* Southwell, 1929 (Dollfus, 1942; Beveridge & Campbell, 1993, 1998).

Beveridge & Campbell (1998) redescribed *Dasyrhynchus pillersi* Southwell, 1929 and discussed in detail the intermediate position of this species between *Dasyrhynchus* and *Pseudogrillotia*. *D. pillersi* is characterised as having a band of spiniform hooks on the external tentacle surface, with enlarged central elements forming a chainette. The number of principal hooks is eight and there is a similar large space between hooks 1 (1') on the internal tentacle surface, which is also observed in *M. coelorhynchi*. Thus, *D. pillersi* has to be allocated to either *Dasyrhynchus* or *Microbothriorhynchus*, depending on the interpretation of the enlarged band elements as a chainette. Interestingly, the bulb length in this species is shorter (figure 40 in Beveridge & Campbell, 1998) and thus resembles species of *Pseudogrillotia*.

Microbothriorhynchus coelorhynchi and *M. reimeri* n. sp. differ in the metabasal armature, as well as in the presence and absence of a characteristic basal armature. In *M. coelorhynchi*, eight principal hooks can be clearly distinguished from intercalary and external hooks, and three rows of one or two intercalary hooks are visible. The characteristic basal armature includes a small rectangular field of hooks on the external tentacle surface, similar to that illustrated for *Dasyrhynchus magnus* and *D. thomasi* Palm, 2000 (see Beveridge & Campbell, 1993; Palm, 2000). Additionally, the shape of hooks on the external tentacle

surface is similar to that described for the metabasal armature of *D. pillersi* and *D. talismani* (see above). By contrast, *M. reimeri* n. sp. has no distinct basal armature and the number of intercalary hooks is three or four, with the hooks being more numerous than in *M. coelorhynchi*. The two characters discussed above thus provide evidence for a close relationship between the genera *Microbothriorhynchus*, *Dasyrhynchus* and *Pseudogrillotia*.

Microbothriorhynchus coelorhynchi was originally described from *Caelorinchus* sp. and *M. reimeri* infests *Caelorinchus parallelus* and *Helicolenus maculatus* obtained from depths of 680 and 470 m. Deep-water fish, including gadoid macrourids, seem to be the preferred host for the genus. Gadiform fish are already known to harbour *Grillotia* spp. (*G. erinaceus* group in *Gadus morhua* and other north Atlantic gadids, see Dollfus, 1942), and *Grillotia rowei* Campbell, 1977 has been described from the deepwater macrourids *Coryphaenoides* spp. (Campbell et al., 1980; Klimpel et al., 2001).

The present study uses the alternative classification of Palm (1995, 1997), assigning *Microbothriorhynchus* to the family Lacistorhynchidae Guiart, 1927, which includes *Grillotia*, *Pseudogrillotia* and *Dasyrhynchus*, and combines poecilacanthous and heteroacanthous atypica genera within a single family. This fits with the observations presented above. By using the classification scheme of Campbell & Beveridge (1994), the Lacistorhynchidae are defined as possessing a tentacular armature with a chainette and, using their key, *Microbothriorhynchus* is assigned to the family Grillotiidae, superfamily Otobothrioidea.

Beveridge et al. (1999) presented a preliminary cladistic analysis of the order Trypanorhyncha, which separated *Grillotia* and *Pseudogrillotia* species in clade 6 from *Dasyrhynchus* in clade 7. This was consistent with the classification by Campbell & Beveridge (1994) where these genera were assigned to different superfamilies, the Otobothrioidea Dollfus, 1942 and the Poecilacanthoidea Dollfus, 1942. However, this does not reflect the close relationship between the genera as proposed above. Thus, *Microbothriorhynchus* and the related *Dasyrhynchus* might be a further case of the independent transition of heteroacanth atypical armatures to a poecilacanthous type.

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